

EXCESSIVE RAINS CAUSE OF SLIDES

Nine Million Cubic Yards of
Dirt to be Removed From
Panama Canal.

WHAT THE SPECIAL BOARD OF SCIENTISTS SAYS ABOUT THE PANAMA CANAL

Slides of nine million cubic feet of earth are being removed at the rate of a million yards a month.

But the canal will be in operation long before the nine months are up.

There may be further slides, but it is not true that the canal is likely to be tied up repeatedly for long periods.

Excessive rainfall causes the slides. The precipitation at Culebra is 87 inches a year.

Preventative measures suggested: Vegetation on the slopes, closing of cracks, drainage by tiles, open drains and other methods, a cut made by sluicing in the east Culebra slide. Trouble is unlikely at any point outside the mile through Culebra.

International News Service:

WASHINGTON, March 24.—Panama canal slides are caused by excessive rainfall, the most important remedies for which are drainage, and sluicing, according to a report submitted to President Wilson today by the committee of eminent engineers and scientists, which recently completed an investigation on the isthmus. William H. Welch, president of the National Academy of Science, is chairman of the committee.

Despite the 9,000,000 cubic yards

of earth yet to be removed can be dredged out only at the rate of 1-600,000 cubic yards a month, the president is informed that the canal will not be closed for a period of nine months, but that it can be opened as soon as the channel is sufficiently deepened and the slides become so low that dredges, even when interrupted by the passage of ships, can keep ahead of the movements of earth.

Slides in Culebra cut will continue to cause considerable expense to the nation for a number of years, the committee declares, and the possibility of further trouble at Culebra is pointed out. The report says it is the firm belief of the committee that after the present difficulties have been overcome navigation through the canal is not likely again to be seriously interrupted. There is declared to be absolutely no justification for statements that traffic will be repeatedly interrupted for long periods in years to come. The canal will serve the great purpose for which it was constructed and the realization of that purpose in the future is assured, the report says.

Discussing the remedy for present conditions, the committee declared that every available and practicable device should be used to turn the water falling as rains from all ground that is sliding and to prevent it from entering adjacent ground. The following remedial measures are suggested by the committee:

"Covering slopes bordering the slides with vegetation, closing of peripheral cracks, which exist for a long time before earth movements begin; drainage of undisturbed and threatened areas by means of surface and tile drainage; drainage of the great slides by establishing complete system of open drains; drainage by tunnels, which should be tried with caution and extended only in cases which promise results commensurate with the cost; that a cut made by sluicing in the east Culebra slide, starting at an appropriate point on the canal and diverging from it diagonally in a general southeasterly direction in a zone of gentle slopes. The committee recommends affecting chiefly the Culebra district, since the three great

slides are all in this district, which is the principal area of danger."

The president is informed that sliding ground will continue to enter the canal for several years to come, though in diminishing amounts, but it is suggested that relatively inexpensive measures which tend to arrest the present active slides, or which promise to reduce the charge against maintenance of the canal in the future are warranted.

"The composition of the rocks, their structural weakness and earthquakes all instrumental in producing the slides, are beyond the control of man, but a partial control of ground and rain water and the relief of pressure by unloading certain areas are feasible, and the committee confines its remedial suggestion to these measures," the report states.

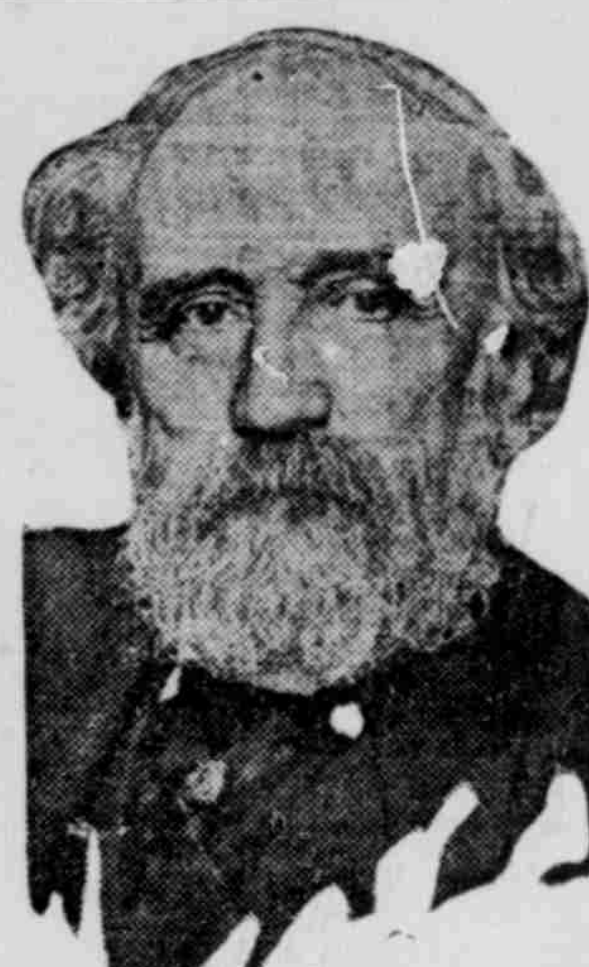
"The slides in the canal zone are essentially like many in other parts of the world; they are due to the inability of the earth or rock to support the weight of overlying material. Slow processes of natural erosion, rapid cutting by flooded streams and excavations by man frequently lead to landslides. Much of the canal is cut through weak rocks; and in the Culebra district the prism is exceptionally deep.

"The rocks of Culebra district are of two kinds—stratified and massive. The chief material involved in the slides is the stratified Cucaracha formation. It is composed of slippery minerals which are only weakly consolidated. The Cucaracha beds are limited, along the line of the canal, to the Culebra district, but they have a thickness in places of over 400 feet. The soft slippery nature of its materials are their loose, unconsolidated condition, make it unusually weak and unable to sustain any considerable load.

"The strength of the Cucaracha clays is greatly decreased by the presence of water, and the heavy tropical rains keep them nearly saturated the greater part of the year; for the broken and irregular surface of the slides borders greedily drink around their borders and open cracks in the water that falls upon them.

"In the Culebra district the average rainfall since 1884 has been

RIBOT SEES END OF WAR



ALEXANDRE RIBOT.

Alexandre Ribot, French minister of finance, believes the end of the war is in sight. In a thrilling speech in the chamber of deputies in Paris, he said:

"We have reached the decisive hour. We can say without exaggeration, without illusion, and without vain optimism that we now see the end of this horrible war."

The speech of the minister of finance is taken as an expression of the government's confidence regarding the outcome of the battle at Verdun. A wave of optimism is sweeping France.

57.68 inches per annum, of which about 80 inches falls in the rainy season of about eight months. Where nearly seven feet of water fall upon the surface of the country within eight months of the year, it is not surprising that there is difficulty in controlling the underground seepage. Indeed, during these months the ground water table is practically at the surface, except possibly on the steeper slopes; and the movement of the underground water is so slow that even in the dry season the water table is not far from the surface in the level country. There is no evidence that any of the slides have been started or increased by earthquakes.

"In addition to the danger of the slides, there is no danger that the canal may be blocked by the fall of the hills of Culebra district.

"The excavation of the canal, and borings in its bottom show that a narrow belt between the two hills is composed of the soft Cucaracha beds; yet to the present time there has been no upheaval of the bottom of this part of the canal, nor any other sign to indicate that the hills have settled. It is believed, therefore, that the great masses of gold and contractors' hills are self-supporting and will remain so. There is no occasion to raze them.

"In addition to the immediate remedial measures suggested above, there are certain observations and protective measures which should be undertaken with a view to the future. A few slides are now in motion, but many more are quiescent. A slide is not necessarily 'dead' because it has not moved notably for a few years. Its stability may hang on a delicate balance which may be disturbed by some slowly developing weakness. There is also a bare possibility that gold and contractors' hills are not so firmly supported as they are believed to be. Repeated surveys of properly placed signals for a number of years to come should be made.

"Two or three core borings should be made on each side of the canal, to study the nature of the high hills. A mechanical testing of the strength of various rocks is suggested since the future of the slides is largely dependent upon the strength of the rocks. Greater facility for the study of earthquake shocks in this region are also recommended.

"Culebra district is the chief area of danger. Slides may occur in other parts of the canal, but they will be relatively small, and infrequent; for the banks are not high, and the unstable ground has already slid down so that its surface has approached the angle of repose. Should slides occur, they are not likely to menace the operation of the canal. Slides, great enough seriously to obstruct traffic in the canal, could occur only in the Culebra district, which is but one mile long.

In general, the committee believes that no great extension of these slides is probable, because the soft rock constituting a very large part of the slides is quite limited in extent, except east of the east Culebra slide, and conditions elsewhere are unfavorable for extensions.

The committee of investigators consists of: William H. Welch, Charles R. Van Hise, president of the University of Wisconsin; Gen. H. L. Abbott, corps of engineers United States army; John C. Branner, geologist and former president of Stanford university; Whitman Cross, geologist in the United States geological survey; R. C. Carpenter, professor of mechanical engineering in Cornell university; Arthur P. Davis, chief of the Reclamation service, Washington; John R. Freeman, construction engineer, Providence; J. F. Hayford, dean of the College of Engineering, Northwestern; Harry Fielding Reid, professor of engineering, Johns Hopkins university.

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